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>> Thank you for coming and for those of you tuning in online, we appreciate you taking time off your day to listen to Emily Farr. She is a Knauss Fellow in Habitat Conservation currently and she is has a Masters from the Yale School of Forestry and Environmental Studies and a Masters in Food Studies from the University of Gastronomic Sciences. This talk will focus on research she conducted as a research fellow with the Maine Center for Coastal Fisheries. It is entitled "How do fishermen understand the ecosystem? Local ecological knowledge and Maine's Commercial Fisheries. I will turn it over to Emily.

>> [Applause]

>> Thank you, Bridget. I will be talking about the project I was working on in eastern Maine at the Maine Center for Coastal Fisheries looking at ecological knowledge of commercial fishermen.

>> Here we go. I will set the stage a little bit and tell you about why we decided to work on this project. The Maine Center for Coastal Fisheries is a nonprofit that focuses on collaboration between fisherman knowledge and science as well as constructive and creative engagement of fishermen's voice meant -- voices and so there is a lot of talk in eastern Maine talking about moving to Eagle-based system at a small pilot scale and they Maine Center for Coastal Fisheries is invested in making sure the voices and knowledge of the fishermen are involved. The project was an opportunity to start to begin to explore that knowledge and eastern Maine and how can be integrated into that process.

>> The second piece which I will talk about in the next 20 minutes is fisheries access and licensing. The Maine Center for Coastal Fisheries also has a mission to ensure eastern Maine is a place for communities to fish forever and part of that means diversified access to fisheries in the fishermen can adapt to a changing social and ecological landscape. I will talk a lot more about access but the idea behind the project was if we want to understand how the knowledge of

fishermen can contribute to ecosystem-based fisheries management we need to understand how management is shaping or contributing to the knowledge. We had hypothesized access is a key mechanism and shaky -- shaping that knowledge.

>> What is local ecological knowledge, which I will refer to as LEK because it is easier to say but it is a form of information about the natural environment and accumulated by interacting on a regular basis and all the and find scaled continues are transmitted from one generation or socially. In this case it is really the knowledge that fishermen accumulate by fishing.

>> The long history of research about how fisherman knowledge can and has contributed to more effective fishery management and really provided a scientific information. The first piece of that the knowledge of fishermen is often creating science scale and they are on the water any regular basis and they see processes and changes in relationships in their fishing in the areas they are fishing and it can help us to the find scales and understand what is going on. The second piece like I mentioned is ecosystem-based fisheries management and again fishermen are able to, they are not just seeing what it is they are targeting but interactions between different species and the environment and they can help us with the shift toward management but not just look at single species. The final piece is change. Fishermen can provide a lot of environmental history and information about long-term trends and environmental changes which can help with research and climate change and formulating the right research questions asked and also think about strategies for adaptations of management. That is the first piece of the triangle I will talk about.

>> This is where I will talk about the rest of the talk which is about the relationship of local knowledge and feeding into fisheries management and how does it shape access to fisheries and how does it shape knowledge.

>> Looking at the second piece of the triangle, how fisheries management determines access to fisheries. It is really who can fish where and when and how often and for what. We were working in the context of eastern Maine and there has been a lot of specialization in the main fishing and there has been a lot of spaces in the past few decades. People used to fish and now many people are fishing for one thing which is lobster and that is probably because they are abundant and profitable but also partly because the license or permits to fish for other species are more difficult to obtain once given up and they are a lot harder to get as a new fish enter the fishing landscape. The majority of fishermen in Maine rely on state fishery, mostly lobster followed by shellfish and Marine worms. In the state context which is what this figure is describing, the evolution of the licensing system in Maine from 1977 through the present and what this is showing is in 1977 there were 5 licenses that allowed you to fish for a variety of different species and over the course of the last several decades, there has been a splintering of license whereby each license allows you to fish for a specific thing. For example if you look at

the blue in the middle, once you are able to fish for the shellfish and mussel and clam with one license and now you need an individual license to fish for each of those. In fact access to state fisheries has declined over 50% in the last 25 years and today 66% of fishermen hold only one license and it is hard to obtain new licenses and that landscape. This has very significant implication for the resilience of the fishermen to change in the system. The diagram is from a paper by Josh Stoll who I work closely with on our project. In the federal context, there was a lot of historic participation in groundfish and Eastern Maine but a changing landscape and a shift in the groundfish toward the system made it pretty hard for Maine to retain access to the fisheries and again the fishermen had small diversified operations with low landings and often underreported their landing data and when there was a shift for an allocation that was based on catch history they were not able to demonstrate the history and a lot of the fishermen no longer have access to groundfish. In general there is a constraining of access in the Maine landscape.

>> Looking at this triangle which is what we wanted to explore with this project, understanding how this access to fisheries shaped the knowledge of fishermen and what that means for management. Obviously not all fisherman knowledge is the same and it is geographically limited and unequally distributed between individual fishermen and constrained by the social context such as management and institutions and technological and social context. We wanted to know what is it that is really driving variability in the knowledge of fishermen and eastern Maine and what role does fisheries access play in that picture.

>> The questions we were asking were, first what types of knowledge do fishermen have about the ecosystem when they are on the water? How does the knowledge vary between the individual fishermen based on different interactions with the ecosystem? We were looking at. If the patient in fisheries as the interaction. Finally, how do management structures, project those dictating access to fisheries, shape or ability in that knowledge?

>> This of the geographic area we were working on and eastern Maine which is Hancock and Washington counties which are two highly fisheries dependent counties in the U.S. Fishing plays an important role in the economic and social fabric of the area and this is a good place to think about fisherman knowledge and what it means.

>> What did we do? We interviewed 17 commercial fishermen and 12 different harbors ranged in age from 25 to 71 years and participated in one and on fisheries and it covered 18 different fisheries. We wanted to understand the interaction and relationship fishermen were observing and we asked about preferred habitat of the species they were targeting, the ecological and biophysical parameters that affected those species, the food web relationships and the environmental and socioeconomic change they observed. All of those interviews were recorded and transcribed and coded and based on the themes that emerged from the interviews and we

organize that information.

>> To show you how we organize information the fishermen were describing and what it looks like, this is, there were four primary categories of information we identified. The radius of the circle is indicating how many times the type of information was described. The most common thing that fishermen talked about was ecosystem structure which is referring to the antibiotic and biotic components of the ecosystem and how they fit together. It included things like water temperature and food web relationships, current pattern type and one example is a lot of fishermen talked about which bottom type was referred by different species. The second most common category was ecosystem dynamic and it was really more the processes in the ecosystem fishermen were observing and it included things like the drivers of abundance and distribution of different species and their behavior and as an example fishermen talked about descriptions of lobster movement or migration along the bottom. The third category is social context and it included things like technological change and market, source of knowledge and social change. A lot of fishermen described how they accumulated information they were talking about and they learned from older fishermen and previous generations. The final category was environmental change and it really overlaps with all of the others but included a lot of information about water temperature and changing fishing patterns in the most common thing people talked about were changes in various spatial distributions of species over time and while they thought that was happening.

>> We wanted to be able to systematically look at individual knowledge and collective knowledge and analyze variability among fishermen they were talking to. We decided to construct cognitive maps for each interview based on the information they fishermen were describing. Cognitive maps are really qualitative models of a system composed of variables or nodes and relationships between the nodes or the edges and they can be used to produce the graphical representations of knowledge which is a type of network. In this case, the nodes are the ecosystem components or characteristics so things like water temperature and scallops, and the edges are the relationships between those notes. We identified 4 primary relationships that encompass the nodes and things fishermen were talking about. The first is drivers of species abundance or distribution as an example a lot of fishermen talked about how water temperature drives lobster movement. Species behavior, which included things like lobsters mold when the water warms and that is water temperatures driving lobster molting. System health, which encompassed information like nutrient content and how the important of the size of different species and the growth rate and food web relationships and what is eating what.
>> We analyze all of those maps using a network approach that allowed us to make a comparison between individuals based on the structure of those cognitive maps they described. I will walk you through an example to show you how we got from the infirm nation information to the maps.

>> In this case I after you decide where to set your lobster trap and he said, when you have the deep-sea jellyfish are changing pointing up in May and June, water columns are getting warmer. When that starts happening, lobster start migrating north and another telltale water temperature indicators when the migratory Bird offspring cluster up and start to swim around this island the lobsters are generally right at the head of the bay. What I hear from that is, jellyfish are eating plankton and that is a red food relationship, water temperature is important for the lobster jellyfish and bird movement and the relationship, and water temperature is in important dose important for the lobster which is at the bottom which is for the distribution relationship. We did this for every interaction relationship described by all 17 fishermen that we interviewed.

>> This is two examples of two fishermen and their cognitive maps scaled out from all of the relationships they described. Here, I want to draw your attention to the difference in participation of these two fishermen. The fishermen on the right-hand side, or on the left, has only a participated in lobster and the one on the right has been in seven fisheries over the course of his lifetime. There is always a lot of other differences between them like age and geography and length of experience but I want to pay attention to the diversification piece for now. You can see really the complexity in the number of relationships described by the diversified fishermen which is a lot greater than a lobster. He was able to describe how lobsters interact with their physical environment and what they are eating and the diversified fishermen talked about how all these different species interact with each other and how, what the causal relationships in the ecosystem looked like.

>> When we plotted participation, how many fisheries have an individual participating participating in the course of time fishing, again the size of the network, which includes both a number of components in the ecosystem they described as well as the number of relationships they described and there was a statistically significant relationship between them. Diversified fishermen had larger networks and able to describe more of the ecosystem. Interestingly they also had more complex networks which is another measure of the structure of the network which indicates the cool reality in the system and they were able to better describe the causal processes that were the more specialized fishermen.

>> This is the cognitive map or network from all 17 interviews. I want to put this appear because it is a really amazing amount of information in this a 17 people that I talked to each one for no one knows no more for an hour and a half or two hours and it describes 229 components of ecosystem and 635 relationships between them. This table is showing what is most common in the relationships and you'll notice they all involved lobster because 12 of the 17 fishermen I talked to were in lobster fisheries and this is not obviously representative of all fissures knowledge and eastern Maine but a starting point of what the variability will look like. Just to parse out what it means, the most common relationship was water temperature and is important

for the abundance or distribution of lobster. The width of each line is the number of fishermen describing that relationship. Here is lobster and here is water temperature and that purple line of that relationship between them, the second most common was cod lobster and again this is lobster and that is cod and that is the food relationship of the food web. The point is the aggregation of knowledge of the 17 individuals is way greater than any individual understanding of the ecosystem.

>> Just to conclude, the collective body of fishermen of ecological knowledge can give social dynamic changes on multiple scales and the fishermen I talked to described broad climate changes in the Gulfstream to specific observations in particular much slack and I think that is a particular element in thinking about fishery management and the scales of management. As regular tray measures and fisheries management increasingly constrain the ability of these individuals to enter diverse fisheries, the diversity and scope of their knowledge can also constrain and I think as it is capacity to their engagement and management. If you are not able to observe a lot of relationships in the ecosystem you're less able to contribute to management in that ecosystem. We need to pay close attention to institutions that shape the production of ecological knowledge if we are to move toward a more participatory ecosystem approach to managing fisheries. Finally I think it is important to understand how management shape knowledge and in order to determine who to engage in what topics, we obviously, managers have limited research and time and figuring out who can provide what kind of information is important to understand.

>> With that, thank you for listening and I'm happy to answer any questions.

>> [Applause]

>> Are there any questions in the room?

>> In this case, I did not. I spent time interviewing fishermen in Italy in a prior, the question was, sorry, they were wondering if I looked into published literature to see if any of the information fishermen were describing were absent in the literature. In a prior work in a number of years ago I was talking to a fisherman in Italy with climate change and I did a lot of work looking at literature to see comparisons and similar to this project, most differences where's the scale I think and fishermen are describing things that are different scale than scientific interpretation. Fishermen I talked to in one co-or bay were saying opposite things that other fishermen saying and another bay because things are happening later or the currents were different things like that. Really the scale is not representative.

>> That is tricky. I do not necessarily think it is about scaling up as it is about tailoring the

management to the appropriate scale. Obviously this is really time intensive, but just recognizing things and processes are occurring at a scale that management is not accounting for so it is less about scaling up in fisheries about scaling down in context.

>> Yes. I think, the question was, sorry, whether I looked at management fishery counsel and other management arenas that may be incorporating some of the knowledge. I think in the fishery management Council, and the New England counsel, it is not operating at a scale for the information specifically I was talking to fishermen about. I think in the state of Maine, there are a number of management bodies that are made up of fishermen that are really incorporating the lobster fishery which has lobster after -- advisory Council and the skillet fishery has a system of rotational management that involves a lot of industry members in the process and in those arenas, their knowledge is being incorporated.

>> I will hop back between online or the room. Do you have any experiences where fishers' LEK contradicts scientific observations? What do you do in that situation?

>> Good question. I am in a funny situation where I feel like most of my ecological knowledge about the ecosystem is from fishermen because that is what I have done. With that said, I think there are certainly times a fisherman will say something that is out of line with what I have learned from a scientist. In this particular project, my job was not to ask questions about the validity of knowledge but to catalog and capture and understand what the knowledge looks like. I think really what that requires is getting scientist and fishermen in the room to talk to each other and parse out why they see something that contradicts what I as a scientist understand and what may be going on that is causing that knowledge to be created.

>> The question is, are there studies are examples where fishermen knowledge is validated with science or whether locally ecological knowledge can be used to generate a research question. Yes, I think for the first part, yes there is definitely a number of published papers that are looking at fishermen knowledge in certain contexts and validating such a speaker comparing with scientific information. I think the second piece is super important and that was a big driver of this project. It was water fishermen thing that we may not be realizing that we should pay attention to and may not be asking those questions? As mentioned at the beginning, there is a research and development agreement between the Maine Center for Coastal Fisheries in the state of Maine but just getting started and starting to think about fisheries management and just eastern Maine and a really small context and part of that and part of this project Inc. that process was water some the questions we can ask to start to think about the shift and how can fishermen form those questions. I think that is very important.

>> How do fishermen react to your findings and have you been able to re-gnash communicate

this to [Indiscernible - low volume].

>> Yes. A few weeks ago I had the opportunity to go back up to Maine and present this work with a fisherman I interviewed and get their feedback about how they thought it was useful and what to do with it. I was pleasantly surprised when the folks were able to come to the meeting were positive and excited. I think they would like to see more, their feedback is really how can we get more people in the field talking to us, especially at the state level.

>> Questions in the room?

>> The question is whether when I was analyzing the cognitive maps if there were values that were shaping those maps. Yes, that is an interesting question. Certainly. I did not key in on that per se and I think -- most people participate in the lobster fishery and they are really dependent on that. A lot of people talk about how they are seen cod coming back more than they have in the recent years and they are worry -- worrying about that and so that the cot eat all of our lobster and it was emphasized as the value they see in the fisheries they participate but I did not look particularly at value systems but that largely comes into play.

>> Yes and only adding notably, I am's are repeating the question, thinking about the individual who just fish lobsters about those who participated in a lot of other fisheries including lobster, did they have a different understanding of the lobster fishery or relationship with lobster as a result. I think absolutely. The diversified fishermen definitely talk more about the balance between different species than fishermen who were targeting just one and that is what they focused on. Yes, I think part of that is seeing the give and take in different fisheries and thing how one gear months with another or how depletion of the urgent impacts help and seem like that so participating in fisheries change about the way they talked about fisheries for sure.

>>Question online, Is there a strong interest in diversification among fishermen in Eastern Maine? Are specialized fishermen aware of their more narrow scope of the greater ecosystem?

>> Yes. Definitely. The reason the Maine Center for Coastal Fisheries and interested in diversification is because fishermen but that is their biggest interest in that community and how do we ensure if lobster is not in two years, we still have fish industry active. That is a huge concern and especially among the young fishermen I spoke with and anytime you today management meeting, the biggest concern is how can we get young people into more fisheries because they are currently not able to do that. Yes, that is huge.

>> No. It was never intended and the question is whether it was splintering management and the licensing over time and it was meant to constrain axis or what it was for. It was super well

intended to different fisheries basically in response to changes in the ecosystem with the social system and never meant to constrain access and that was the unintended consequences of that.

>> Anymore questions?

>> Something about age differentiations like younger [Indiscernible - low volume] so as the management, it seems like it is limited and it seems like management to an extent, I guess the question is how do you see that changing is the agency across the management starts a recourse in the base model?

>> If I understand the question, in this constraining of access and fisheries are swallowed and axis is followed as the management system and as we start thinking about and following the system, what will the knowledge look like? Or to make yes, --

>> Yes as we are seeing the process, do you see in knowledge and access to fisheries changing?

>> I would hope so, yes. I think, you mentioned age and interestingly, I only talk to 17 people and there are plenty of questions I could not answer and age is not significant in scope of knowledge. It may just be because I talk to young people who had really knowledgeable service and an individual and things like that but, yes, I think if people have access to more fisheries they will be able to observe more parts of the ecosystem. I do not know or I do not think it is an easy shift and I do not see access opening up in the short term even with a shift, there are just so many factors in the process but that would be great. That was a way to do it well.

>> What are the next steps for your findings?

>> This was really a pilot project and in the context of that pilot that is happening, hopefully some of the work will be expended with the greater pool of fishermen and asking more specific questions that can be relevant and applied to management or setting up a science framework for the EBFM so the next steps are to do more of this but maybe more narrative.

>> Was there a paper published a report published in where can we find it?

>> Yes, there is a paper that is forthcoming at some point in *Ecology and Society* that will be up sometime, hopefully soon.

>> Anymore questions?

>> If not, thank you for coming.

[Applause]

[Event Concluded]